What is the relationship between the intake of milk and milk products and blood pressure?

Conclusion

A moderate body of evidence suggests an inverse relationship between the intake of milk and milk products and blood pressure.

Grade: Moderate

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades, click here.

Evidence Summary Overview

Based on the current review of research of literature published since 2004, there is little evidence that supports an independent relationship between the intake of milk and milk products and blood pressure (BP). This conclusion is based on one systematic review (Alvarez-Leon, 2006), one randomized controlled trial (RCT) (Bowen, 2005), six prospective cohort studies (Alonso, 2005; Engberink, 2009a; Engberink, 2009b; Snijder, 2008; Toledo, 2009; Wang, 2008) and five cross-sectional studies (Azadbakht, 2005; Beydoun, 2008; Djousse, 2006; Houston, 2008; Ruidavets, 2006).

The systematic review by Alvarez-Leon et al (2006) concluded that an inverse association exists between the intake of dairy products and hypertension (HTN). In the Bowen et al (2005) RCT, the authors determined that weight loss following energy-restricted, high-protein diets is not affected by dietary calcium or protein source. Also, weight loss, not dietary calcium, was shown to improve BP.

Results were reviewed from six prospective studies conducted in the Netherlands, Spain and the US. In the Women's Health Study (Wang, 2008a), decreased risk of HTN was associated with low-fat dairy products, calcium and vitamin D. In the Seguimiento Universidad de Navarra (SUN) cohort in Spain, Alonso et al (2005) reported a 54% reduction in HTN in participants with the highest consumption of low-fat dairy products compared to those with the lowest consumption, and they found no association between whole-fat dairy or total calcium intake and incident HTN. Likewise, the Toledo et al (2009) study in Spain found no significant (NS) relationship between high-fat dairy and BP, but BP was significantly lower among the highest consumers of low-fat dairy products.

In general, studies from the Netherlands did not show as strong a relationship between the intake of milk and milk products and BP. Engberink et al (2009a) followed more than 20,000 participants for five years in the Netherlands and concluded that dairy intake has little effect on population BP. Snijder et al (2008) concluded that dairy consumption was not associated with changes in metabolic variables in their study with a Dutch elderly population. Engberink et al (2009b) followed older Dutch participants for six years and they concluded that low-fat dairy may be related to HTN prevention, but high-fat dairy and cheese did not show the same effect.

Five cross-sectional studies (Azadbakht, 2005; Beydoun, 2008; Djousse, 2006; Houston, 2008; Ruidavets, 2006) conducted in Iran, France and the US also were reviewed and all showed some positive impact of milk and milk product consumption on BP, although the results were not

consistent for all population groups. Using data from National Health and Nutrition Examination Surveys (NHANES) 1999 to 2004, Beydoun et al (2008) found that among all study participants, and among men in particular, fluid milk was inversely related to BP (systolic and diastolic BP), and yogurt was associated with better systolic blood pressure (SBP). In contrast, cheese was positively associated with SBP. Using data on the intake of cheese from NHANES III, Houston et al (2008) found that SBP was not different across categories of cheese consumption, but diastolic blood pressure (DBP) was higher among men in the highest category of cheese consumption compared to non-consumers. In a cross-sectional analysis of almost 5,000 participants from the National Heart, Lung and Blood Institute (NHLBI) Family Heart Study, there was an inverse association between dairy intake and the prevalence of HTN that was independent of calcium intake and seen mainly among participants consuming less saturated fat. A cross-sectional analysis of 1,500 participants in Iran (Azadbakht, 2005) showed an inverse relationship between dairy consumption and HTN. Finally, the French study by Ruidavets et al (2006) concluded that the consumption of dairy products may be associated with reduced BP.

Evaluating the research on this topic is complicated by the types of milk products consumed in the various studies, potential confounding with calcium intakes from other food sources, and the known relationship of BP to weight loss.

Evidence Summary Paragraphs

Systematic Review

Alvarez-Leon et al, 2006 (positive quality) systematically reviewed papers on the associations between consumption of dairy products and health outcomes, including cancer, bone health and cardiovascular disease (CVD). Relevant articles were obtained through searching the MEDLINE database (from 1966 to January 2005) using the search terms: 'dairy products,' defined as 'raw and processed or manufactured milk and milk-derived products' including butter, cheese, ice cream, margarine and milk and cultured milk products (yoghurt). This search revealed 85,000 articles. After excluding studies, and including only meta-analysis and systematic reviews, the final sample consisted of 14 meta-analyses and systematic reviews. This final sample consisted of six papers on dairy products and cancer, six papers on dairy products and cardiovascular disease and two papers on dairy products and bone health. Four articles specifically addressed HTN. Evidence from these papers was summarized and evaluated. The authors concluded that there is an inverse association between the intake of dairy products and HTN.

Primary Research

Trials

Bowen et al, 2005 (positive quality) conducted a randomized controlled trial (RCT) to compare the effects on weight, body composition, metabolic parameters and risk markers of two isocaloric, energy-restricted high protein diets that differ in dietary calcium and protein source on weight loss and body composition in healthy, overweight adults (N=50, 30 women and 20 men, ages 25 to 64 years). The study was conducted in Australia. The intervention diets were a high dairy protein and high-calcium (DP, 2,400 mg Ca per day) diet and a high mixed protein and moderate calcium (MP, 500mg Ca per day) diet followed for a 12-week energy restriction phase, followed by a four-week energy balance phase. After 16 weeks, subjects showed significant reductions in total weight (-9.7±3.8 kg), fat mass (-8.3±0.4kg) and lean mass (-1.6±0.3kg), but there were no significant (NS) differences between the two diet groups. Systolic and diastolic blood pressure were significantly lower at week 16 compared to baseline independent of dietary group and gender. Overall, SBP decreased by 9.4±1.4mmHg from baseline to week 16 ($P<0.001$). The largest decrease occurred

between week zero and four (-7.6±1.3mmHg; P<0.001) and remained relatively stable between week four and 16. Similarly, DBP decreased by 2.5±0.9mmHg from baseline to week 16 (P<0.001). The largest decrease occurred between baseline and week four (-4.4±0.9mmHg; P<0.001) and remained stable from week four to 12.Diastolic blood pressure increased by 2.1±0.8mmHg from week 12 to 16 (P<0.01). There was no relationship between baseline BP and weight loss or dietary group. The authors concluded that weight loss following energy-restricted, high protein diets is not affected by dietary calcium or protein source. In addition, BP improved with weight loss independent of dietary protein source or calcium intake.

Prospective Cohort Studies

Alonso et al, 2005 (positive quality) conducted a prospective cohort study to assess whether total, low-fat and whole-fat dairy product consumption was associated with risk of HTN in a group of Spanish adults [Seguimiento Universidad de Navarra (SUN) cohort]. Subjects included 6,686 adults (mean age = 37 years) at baseline. Dairy consumption was assessed at baseline using a semiquantitative 136-item food-frequency questionnaire (FFQ), and subjects self-reported whether they were diagnosed with HTN and their most recent systolic and diastolic BP values at baseline and at the two-year follow-up. Subjects were divided into quintiles based on dairy intake: Q1: 155.6±75.3g per day (N=1,177); Q2: 292.4±27.6g per day (N=1,174); Q3: 383.9±29.7g per day (N=1,177); Q4: 530.0±53.0g per day (N=1,176); Q5: 798.8±215.4g per day (N=1,176). At follow-up, 180 new cases of HTN were identified. Results showed a 54% reduction in HTN incidence in participants with the highest consumption of low-fat dairy products compared to those with the lowest consumption (0.46; 95% CI: 0.26, 0.84; P<0.05) after adjustment for main known risk factors for HTN and dietary factors. No significant association between whole-fat dairy or total calcium intake and incident HTN was seen.

Engberink, Geleijnse et al, 2009a (positive quality), a prospective cohort study conducted in the Netherlands, investigated whether dairy consumption, including specific dairy food groups, was associated with BP and risk of HTN in a population-based cohort of participants from the Monitoring Project on Risk Factors for Chronic Diseases. A total of 21,553 participants aged 20 to 65 years who did not use anti-hypertensive medication were included in the baseline analysis; risk of HTN was examined in 3,454 of these participants after a five-year follow-up. Intake of total dairy, specific dairy groups (i.e., low-fat, high-fat, fermented) and dairy products (i.e., cheese, yogurt) were assessed at baseline using a semiquantitative 178-item FFQ. Participants had a median intake of 344g per day of total dairy (approximately 2.3 servings) and 174g per day of low-fat dairy (approximately 1.2 servings); however, the intake of total dairy, specific dairy groups and dairy products were not consistently related to BP. Of the participants who were followed, the risk of HTN tended to be inversely related to low-fat dairy intake (P=0.24). The authors concluded that dairy intake has little effect on population BP.

Engberink, Hendriksen et al, 2009b (positive quality), a prospective cohort study conducted in the Netherlands, assessed whether hypertension is associated with dairy consumption in older adults (over age 55 years). Dietary intake was assessed at baseline through home checklist, interview with dietitian and 170-item semiquantitative FFQ. Blood pressure was measured at baseline, and re-examined in 1993 to 1995 (after two years) and 1997 to 1999 (after six years). A total of 7,983 subjects were available at baseline, with 2,245 having complete dietary and BP data. Risk of HTN after two years of follow-up (664 incident cases) was inversely associated with dairy product intake; after adjustment for confounders, hazard ratios were 1.00, 0.82 (95% CI: 0.67, 1.02), 0.67 (95% CI: 0.54, 0.84), and 0.76 (95% CI: 0.61, 0.95) for consecutive quartiles of total dairy product intake (P=0.008) and were 1.00, 0.75 (95% CI: 0.60, 0.92), 0.77 (95% CI: 0.63, 0.96) and 0.69 (95% CI: 0.56, 0.86), for consecutive quartiles of low-fat dairy product intake (P=0.003). Analysis of specific

types of dairy products showed an inverse association with milk and milk products (P=0.07), but no association with high fat dairy or cheese. After six years of follow-up (984 incident cases), the associations with HTN were attenuated to risk reductions of approximately 20% for both total and low-fat dairy products between the first and last quartiles of intake (P=0.07 and 0.09, respectively). The authors concluded that low-fat dairy intake may be related to prevention of HTN as people age.

Snijder et al, 2008 (positive quality), a prospective cohort study conducted in the Netherlands, investigated the association between dairy consumption and changes in weight and metabolic disturbances, based on data from the Hoorn study, a population-based cohort of white men and women aged 50 to 75 years. Average food intake was measured at baseline using a 92-item semiquantitative FFQ. At baseline and follow-up, participants underwent an extensive physical examination and a blood sample was drawn for biochemical analyses of fasting glucose, post-load glucose, high-density lipoprotein (HDL-C) and low-density lipoprotein (LDL-C) cholesterol and triglycerides (TG). During the physical examination, weight, waist circumference (WC) and BP were measured. A total of 1,124 participants were included in the analysis. Baseline dairy consumption was not associated with 6.4-year changes in systolic or diastolic BP. The authors concluded that dairy consumption was not associated with changes in metabolic variables in a Dutch elderly population.

Toledo et al, 2009 (positive quality) used data from a prospective cohort study to assess the relationship between low-fat dairy product intake and BP levels and change in BP after 12 months in a group of older adults at high risk of CVD participating in a trial on the effects of the Mediterranean diet on cardiovascular outcomes (PREDIMED trial, Spain). Adults (N=2,290, 458 per quintile; ages 55 to 80 years) were divided into quintiles based on low-fat dairy consumption (Q1: 3.1±17.1g per day; Q2: 141.1±53.3g per day; Q3: 236.7±26.8g per day; Q4: 406.1±80.1g per day; Q5: 631.6±139.4g per day). Dietary intake was assessed at baseline and 12 months using a 137-item FFQ, and BP measures were taken at baseline and 12 months by trained personnel. Results showed that adjusted systolic and diastolic BP were significantly lower in the highest quintile of low-fat dairy product intake (-4.2; 95% CI: -6.9, -1.4 and -1.8; 95% CI: -3.2, -.04mmHg, respectively). No significant trends were observed when examining the relationship between high-fat dairy intake and BP. There were also NS interactions between low-fat or high-fat dairy consumption and obesity or diabetes mellitus (DM).

Wang et al, 2008 (positive quality), a prospective cohort study conducted in the US, examined the associations between intake of dairy products, as well as the major nutrient components in dairy products, with the risk of HTN in participants from the Women's Health Study. Out of 39,876 female health professionals in the Women's Health Study, 28,886 women (mean age 54 years) remained in the analysis after application of exclusion criteria. Intake of dairy products, calcium and vitamin D at baseline were assessed from semi-quantitative FFQs, and incident cases of self-reported hypertension were identified over ten years of follow-up. After adjustment for confounding variables, the relative risks of incident HTN across increasing quintiles of low-fat dairy product intake were 1.00 (reference), 0.98, 0.97, 0.95 and 0.89 (P=0.001). The risk of HTN decreased in the higher quintiles of dietary calcium (multivariate RR = 0.87) and dietary vitamin D (multivariate RR = 0.95) but did not change with calcium or vitamin D supplementation. The authors concluded that intakes of low-fat dairy products, calcium and vitamin D were each inversely associated with risk of HTN in middle-aged and older women.

Cross-Sectional Studies:

Azadbakht et al, 2005 (positive quality), a cross-sectional study conducted in Tehran, Iran, ascertained the relation between dairy consumption and metabolic syndrome in a population-based

sample of adults. A representative sample of 1,476 participants were randomly selected from the Tehran Lipid and Glucose Study, including 861 subjects aged 18 to 74 years. After application of exclusion criteria, 827 subjects (357 men, 470 women) were included in the analysis. Dairy consumption was assessed through a 168-item semi-quantitative FFQ, and subjects were categorized into quartiles of intake (less than 1.7, 1.7 to less than 2.3, 2.3 to less than 3.1 and 3.1 or more servings a day). Measurements relevant to the diagnosis of the metabolic syndrome were taken, such as height, weight,WC, BP and fasting blood samples for glucose and lipid concentrations. Mean consumption of milk, yogurt and cheese was 0.7±0.2, 1.06±0.6 and 0.9±0.3 servings per day, respectively; butter and ice cream were not included in the analysis due to their high fat content. Dairy consumption had an inverse association with HTN; odds ratios (OR) by quartile were 1, 0.88, 0.79, 0.71 (P<0.02). These values became weaker after adjustment for calcium intake.

Beydoun et al, 2008 (positive quality), a cross-sectional analysis of merged NHANES data from 1999 to 2004 in the US, assessed the association between consumption of dairy and related nutrients and obesity, central obesity and the metabolic syndrome. Out of 17,061 subjects over age 18 years (8,970 women and 8,091 men) with complete demographic data, 4,519 subjects had complete data on dietary intake (assessed from 24-hour recall data) and metabolic outcomes, such as weight, height, WC, BP and laboratory values (fasting blood glucose, triacylglycerol (TAG) stores and HDL-C). When dairy consumption and related nutrients were examined in relation to individual metabolic outcomes as continuous variables, they found that among all subjects, and among men in particular, fluid milk (servings) was inversely related to blood pressure (SBP and DBP) and yogurt was associated with better SBP. In contrast, cheese was positively associated with SBP.

Djousse et al, 2006 (positive quality), a multicenter cross-sectional study conducted in the US, examined the relation between dairy consumption and prevalent hypertension among 4,797 participants of the NHLBI Family Heart Study (45% were men, mean age 52.2±13.7 years, range 25 to 94 years). Dietary intake of dairy products were assessed through staff-administered semi-quantitative FFQ. There was an inverse association between dairy intake and prevalent HTN; OR across quartiles of dairy consumption were 1.0 (reference), 0.82 (95% CI: 0.64, 1.05), 0.68 (95% CI: 0.53, 0.89) and 0.62 (95% CI: 0.45, 0.84), respectively, P=0.002; this association was independent of calcium intake, and mainly observed among subjects consuming less saturated fat. Dairy consumption was inversely associated with SBP (P=0.003) but not DBP.

Houston et al, 2008 (positive quality), a cross-sectional study conducted in the US, examined the association between the frequency of cheese consumption and several cardiovascular risk factors, including measures of body fat, blood lipids, BP and blood glucose, using data from NHANES III. 10,872 participants, aged 25 to 75 years, had complete data and were included in the analysis. Cheese consumption (combined full and low-fat) was assessed through an FFQ asking one question about cheese and two questions about the consumption of foods containing large amounts of cheese. Categories of cheese consumption were 0, 1 to 4, 5 to 12, 13 to 29 and 30-plus servings per month. Systolic blood pressure was not significantly different across categories of cheese consumption in men or women. Diastolic blood pressure was significantly higher among men, but not among women, in the highest category of cheese consumption compared to non-consumers (P<0.05).

Ruidavets et al, 2006 (neutral quality), a cross-sectional study conducted in France, investigated the relationships between BP and dairy products, dietary calcium and a mixed dieting behavior characterized by a combination of different levels of intake of calcium and dairy products. Participants were recruited from the population as part of the French MONICA Study (Monitoring of Trends and Determinations in Cardiovascular Disease). Anthropometric data were taken, including WC, waist-to-hip ratio (WHR) and body mass index (BMI); BP was measured twice. Intake of dairy products was measured through food records with follow-up interviews by a

dietitian. Four combinations of dairy products were established: 1) Milk, 2) milk plus fresh cheese, 3) milk plus fresh cheese plus cheese, and 4) milk plus fresh cheese plus cheese plus butter. After those without complete data were excluded, 912 men aged 45 to 64 years remained in the analysis. Systolic and diastolic blood pressures significantly decreased from the lowest (145.4±1.55 and 89.0±0.94mmHg, respectively) to the highest quintile (135.6±1.26 and 85.3±0.84mmHg, respectively) of dairy product intakes in bivariate analysis. After multivariate adjustment, the difference in SBP between the two extreme quintiles of calcium intake was 4.1mmHg, for milk intake was 3.8mmHg, for milk and fresh cheese combination was 4.4mmHg, and for total dairy intake was 7.0mmHg. The authors concluded that the consumption of dairy products may be associated with reduced levels of BP.

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Author, Year, Study Design, Class, Rating	Participants	Description of Study Design	Outcomes
Alonso A, Beunza JJ et al, 2005 Study Design: Prospective Cohort Study Class: B Rating:	N=6,686 adults at baseline. Mean age: 37 years. Seguimiento Universidad de Navarra [SUN] cohort. Subjects divided into quintiles based on dairy intake (per day): • Q1: 155.6±75.3g (N=1,177) • Q2: 292.4±27.6g (N=1,174) • Q3: 383.9±29.7g (N=1,177) • Q4: 530.0±53.0g (N=1,176) • Q5: 798.8±215.4g (N=1,176).	Dairy consumption assessed at baseline using a semiquantitative 136-item FFQ. Subjects self-reported whether they were diagnosed with HTN and most recent SBP and DBP values at baseline and at two-year follow-up.	At follow-up, 180 new cases of HTN identified. 54% ↓ in HTN incidence in participants with highest consumption of low-fat dairy products compared to those with lowest consumption (0.46; 95% CI: 0.26, 0.84; P<0.05) after adjustment for the main known risk factors for HTN and dietary factors. NS association between whole-fat dairy or total Ca intake and incident HTN.

	Location: Spain.		
Alvarez-León EE, Roman-Vinas B et al, 2006 Study Design: Meta-analysis or Systematic Review Class: M Rating: 	N=14 meta-analyses and systematic reviews. • Six papers on dairy products and cancer. • Six papers on dairy products and CVD. • Two papers on dairy products and bone health.	Relevant articles obtained through searching MEDLINE database (from 1966 to January 2005) using search terms: 'dairy products,' defined as 'raw and processed or manufactured milk, and milk-derived products' including butter, cheese, ice cream, margarine, and milk and cultured milk products (yoghurt).	Four articles specifically addressed HTN. Authors concluded that there is an inverse association between intake of dairy products and HTN.
Azadbakht L, Mirmiran P et al, 2005 Study Design: Cross-Sectional Study Class: D Rating: 	A representative sample of 1,476 participants were randomly selected from the Tehran Lipid and Glucose Study, including 861 subjects aged 18 to 74 years. N=827 subjects (357 men, 470 women) included in the analysis, after application of exclusion criteria. Location: Tehran, Iran.	Ascertained relation between dairy consumption and metabolic syndrome in a population-based sample of adults. Dairy consumption assessed through a 168-item semi-quantitative FFQ and subjects categorized into quartiles of intake (<1.7, 1.7 to <2.3, 2.3 to <3.1 and ≥3.1 servings a day). Measurements relevant to diagnosis of metabolic syndrome taken, such as height, weight, WC, BP and fasting blood samples for glucose and lipid concentrations.	Mean consumption of milk, yogurt and cheese was 0.7±0.2, 1.06±0.6 and 0.9±0.3 servings per day, respectively; butter and ice cream not included in analysis, due to high fat content. Dairy consumption had an inverse association with HTN; OR by quartile were 1, 0.88, 0.79, 0.71 (P<0.02). These values became weaker after adjustment for Ca intake.

Beydoun et al 2008 Study Design: Cross-sectional Study Class: D Rating:	N=4,519 subjects had complete data on dietary intake and metabolic outcomes (out of 17,061 subjects >age 18 years (8,970 women, 8,091 men) with complete demographic data). Location: United States.	Analyzed merged NHANES data from 1999 to 2004 in the US, assessed the association between consumption of dairy and related nutrients and obesity, central obesity and metabolic syndrome. Included subjects had complete data on dietary intake (assessed from 24-hour recall data) and metabolic outcomes, such as weight, height, WC, BP and laboratory values (FBG, TG stores and HDL-C).	When dairy consumption and related nutrients were examined in relation to individual metabolic outcomes as continuous variables, among all subjects and among men in particular, fluid milk (servings) inversely related to BP (SBP and DBP) and yogurt associated with better SBP. In contrast, cheese positively associated with SBP.
Bowen J, Noakes M et al, 2005 Study Design: Randomized Controlled Trial Class: A Rating:	N=50 (30 women, 20 men) Age: 25 to 64 years. Location: Australia.	Compared effects of two isocaloric, energy-restricted high PRO diets that differ in dietary Ca and PRO source on weight ↓ and body composition. Intervention diets were 1) high dairy PRO and high-Ca (DP, 2,400mg Ca per day) diet and 2) high mixed PRO and moderate Ca (MP, 500mg Ca per day) diet followed for a 12-week energy restriction phase, followed by a four-week energy balance phase.	After 16 weeks, subjects showed significant ↓ in total weight (-9.7±3.8kg), fat mass (-8.3±0.4kg) and lean mass (-1.6±0.3kg), but NS differences between the two diet groups. SBP and DBP significantly ↓ at week 16 compared to baseline independent of dietary group and gender. Overall, SBP ↓ by 9.4±1.4mmHg from baseline to week 16 (P<0.001). Largest ↓ occurred between week 0 and four (-7.6±1.3mmHg; P<0.001) and remained

			relatively stable between week four and 16. Similarly, DBP ↓ by 2.5±0.9mmHg from baseline to week 16 (P<0.001). Largest ↓ occurred between baseline and week four (-4.4±0.9mmHg; P<0.001) and remained stable from week four to 12. DBP ↑ by 2.1±0.8mmHg from week 12 to 16 (P<0.01). No relationship between baseline BP and weight loss or dietary group.
Djousse et al 2006 Study Design: Cross-sectional Study Class: D Rating:	N=4,797 participants of the NHLBI Family Heart Study (45% men). Mean age: 52.2±13.7 years (range 25 to 94 years). Location: United States.	Examined relation between dairy consumption and prevalent HTN. Dietary intake of dairy products assessed through staff-administered semi-quantitative FFQ.	Inverse association between dairy intake and prevalent HTN: OR across quartiles of dairy consumption were 1.0 (reference), 0.82 (95% CI: 0.64, 1.05), 0.68 (95% CI: 0.53, 0.89) and 0.62 (95% CI: 0.45, 0.84), respectively, P=0.002; this association was independent of Ca intake and mainly observed among subjects consuming ↓ SFA. Dairy consumption inversely associated with SBP (P=0.003), but not DBP.

Engberink MF, Geleijnse JM et al 2009 Study Design: Prospective Cohort Study Class: B Rating: 	N=21,553 participants who did not use anti-hypertensive medication were included in baseline analysis. Risk of HTN examined in 3,454 of these participants after a five-year follow-up. Age: 20 to 65 years. Location: The Netherlands.	Investigated whether dairy consumption, including specific dairy food groups, was associated with BP and risk of HTN in a population-based cohort of participants from the Monitoring Project on Risk Factors for Chronic Diseases. Intake of total dairy, specific dairy groups (i.e., low-fat, high-fat, fermented) and dairy products (i.e., cheese, yogurt) assessed at baseline using a semiquantitative 178-item FFQ.	Participants had median intake of 344g per day of total dairy (~2.3 servings) and 174g per day of low-fat dairy (~1.2 servings); however, intake of total dairy, specific dairy groups and dairy products not consistently related to BP. Of the participants who were followed, risk of HTN tended to be inversely related to low-fat dairy intake (P=0.24). Authors concluded that dairy intake has little effect on population BP.
Engberink MF, Hendriksen MA et al 2009 Study Design: Prospective Cohort Study Class: B Rating: 	N=7,983 older adults (age >55 years) available at baseline, with 2,245 having complete dietary and BP data. Location: The Netherlands.	Assessed whether HTN is associated with dairy consumption in older adults. Dietary intake assessed at baseline through home checklist, interview with dietitian and 170-item semiquantitative FFQ. BP measured at baseline and re-examined in 1993 to 1995 (after two years) and 1997 to 1999 (after six years).	Risk of HTN after two years of follow-up (664 incident cases) inversely associated with dairy product intake; after adjustment for confounders, HRs were 1.00, 0.82 (95% CI: 0.67, 1.02), 0.67 (95% CI: 0.54, 0.84), and 0.76 (95% CI: 0.61, 0.95) for consecutive quartiles of total dairy product intake (P=0.008) and 1.00, 0.75 (95% CI: 0.60, 0.92), 0.77 (95% CI: 0.63, 0.96) and 0.69 (95% CI: 0.56, 0.86),

			for consecutive quartiles of low-fat dairy product intake (P=0.003). Analysis of specific types of dairy products showed an inverse association with milk/milk products (P=0.07), but no association with ↑fat dairy or cheese. After six years of follow-up (984 incident cases), associations with HTN were attenuated to risk ↓ of ~20% for both total and low-fat dairy products between first and last quartiles of intake (P=0.07 and 0.09, respectively). Authors concluded that low-fat dairy intake may be related to prevention of HTN as people age.
Houston et al 2008 Study Design: Cross-sectional Study Class: D Rating: 	N=10,872 NHANES III participants had complete data and included in analysis. Age: 25 to 75 years. Location: United States.	Examined association between frequency of cheese consumption and several cardiovascular risk factors, including measures of body fat, blood lipids, BP and BG, using data from NHANES III. Cheese consumption (combined full and low-fat) assessed through FFQ asking one question about cheese and two questions about consumption of foods containing large amounts of	SBP was NS different across categories of cheese consumption in men or women. DBP significantly ↑ among men, but not among women, in highest category of cheese consumption compared to non-consumers (P<0.05).

		cheese. Categories of cheese consumption: 0, 1 to 4, 5 to 12, 13 to 29 and 30-plus servings per month.	
Ruidavets et al 2006 Study Design: Cross-sectional Study Class: D Rating:	N=912 men in analysis, after those without complete data were excluded. Age: 45 to 64 years. Location: France.	Investigated relationships between BP and dairy products, dietary Ca and a mixed dieting behavior characterized by a combination of different levels of intake of Ca and dairy products. Participants recruited from the population as part of the French MONICA Study (Monitoring of Trends and Determinations in Cardiovascular Disease). Anthropometric data taken, including WC, WHR and BMI; BP was measured twice. Intake of dairy products measured through food records with follow-up interviews by a dietitian. Four combinations of dairy products established: 1) Milk 2) Milk and fresh cheese 3) Milk and fresh cheese and cheese 4) Milk and fresh cheese and cheese and butter.	SBP and DBP significantly ↓ from lowest (145.4±1.55 and 89.0±0.94mmHg, respectively) to the highest quintile (135.6±1.26 and 85.3±0.8mmHg, respectively) of dairy product intakes in bivariate analysis. After multivariate adjustment, difference in SBP between two extreme quintiles of Ca intake was 4.1mmHg, for milk intake 3.8mmHg, for milk and fresh cheese combination 4.4mmHg and for total dairy intake 7.0mmHg. Authors concluded that consumption of dairy products may be associated with ↓ levels of BP.

Snijder et al 2008 Study Design: Prospective Cohort Study Class: B Rating:	Participants in the Hoorn study, a population-based cohort of white men and women. Age: 50 to 75 years. N=1,124 participants included in the analysis. Location: The Netherlands.	Investigated association between dairy consumption and Δ in weight and metabolic disturbances. Average food intake measured at baseline using a 92-item semiquantitative FFQ. At baseline and follow-up, participants underwent extensive physical exam and blood sample drawn for biochemical analyses of fasting glucose, post-load glucose, HDL-C and LDL-C and TG. During the physical exam, weight, WC and BP measured.	Baseline dairy consumption not associated with 6.4-year Δ in SBP and DBP. Authors concluded that dairy consumption was not associated with Δ in metabolic variables in a Dutch elderly population.
Toledo E, Delgado-Rodríguez M, et al 2009 Study Design: Prospective Cohort Study Class: B Rating:	N=2,290, 458 per quintile. Age: 55 to 80 years. Q1: 3.1±17.1g per day. Q2: 141.1±53.3g per day. Q3: 236.7±26.8g per day. Q4: 406.1±80.1g per day. Q5: 631.6±139.4g per day. Location: Spain.	Assessed relationship between low-fat dairy product intake and BP levels and BPΔ after 12 months in a group of older adults at high risk of CVD. Dietary intake assessed at baseline and 12 months using a 137-item FFQ. BP measures taken at baseline and 12 months by trained personnel.	Adjusted SBP and DBP significantly ↓ in highest quintile of low-fat dairy product intake (-4.2; 95% CI: -6.9, -1.4 and -1.8; 95% CI: -3.2, -0.04mmHg, respectively). NS trends observed when examining relationship between high-fat dairy intake and BP. NS interactions between low-fat or high-fat dairy consumption and obesity or DM.

Wang L et al 2008 Study Design: Prospective Cohort Study Class: B Rating: 	N=28,886 women in analysis after application of exclusion criteria (out of 39,876 female health professionals in the Women's Health Study). Mean age: 54 years. Location: United States.	Examined associations between intake of dairy products, as well as major nutrient components in dairy products, with risk of HTN in participants from the Women's Health Study. Intake of dairy products, Ca and vitamin D at baseline were assessed from semi-quantitative FFQs and incident cases of self-reported HTN identified over ten years of follow-up.	After adjustment for confounding variables, the RR of incident HTN across increasing quintiles of low-fat dairy product intake were 1.00 (reference), 0.98, 0.97, 0.95 and 0.89 (P=0.001). Risk of HTN ↓ in higher quintiles of dietary Ca (multivariate RR=0.87) and dietary vitamin D (multivariate RR=0.95), but no Δ with Ca or vitamin D supplementation. Authors concluded that intakes of low-fat dairy products, Ca and vitamin D were each inversely associated with risk of HTN in middle-aged and older women.

Research Design and Implementation Rating Summary
For a summary of the Research Design and Implementation Rating results, click here.

Worksheets

Alonso A, Beunza JJ, Delgado-Rodríguez M, Martínez JA, Martínez-González MA. Low-fat dairy consumption and reduced risk of hypertension: the Seguimiento Universidad de Navarra (SUN) cohort. *Am J Clin Nutr.* 2005 Nov; 82(5): 972-979.

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Wang L, Manson JE, Buring JE, Lee IM, Sesso HD. Dietary intake of dairy products, calcium, and vitamin D and the risk of hypertension in middle-aged and older women. *Hypertension.* 2008 Apr;51(4):1073-9. Epub 2008 Feb 7.